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S. M. AKEYSON ET AL

2,401,035

WELL SCREEN

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Fig. 1.

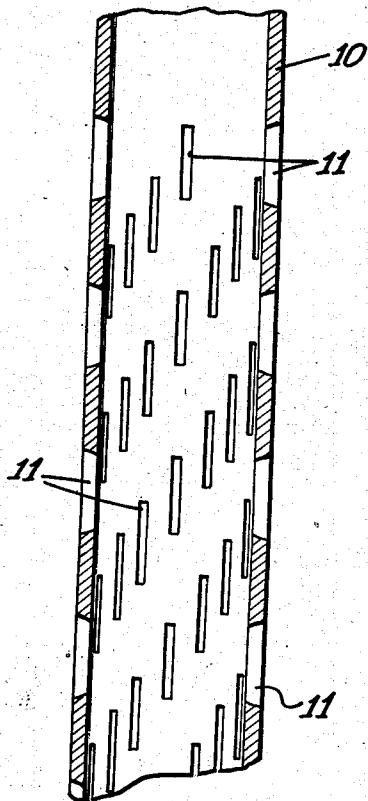


Fig. 2.

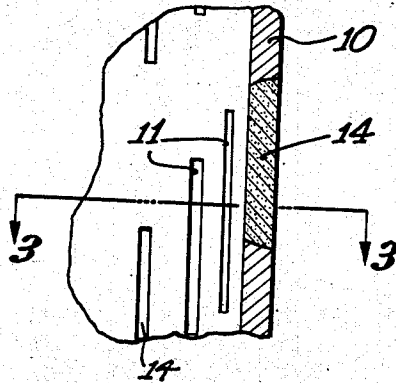


Fig. 3.

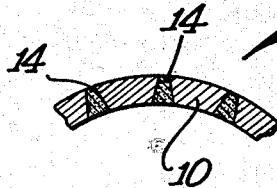


Fig. 4.

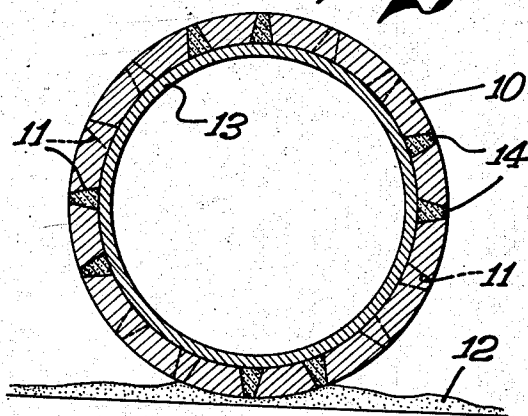
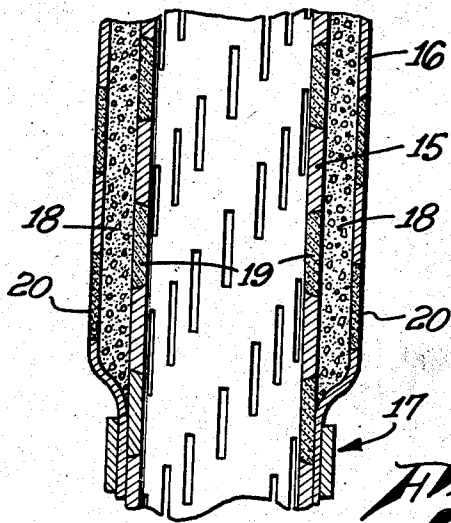


Fig. 5.

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WELL SCREEN

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7 Claims. (Cl. 166-5)

This invention has to do with the conditioning of well screen, by which term we include generally various types and forms of apertured or perforated pipe sections or liners through which production fluid is taken from the formation into the well casing or flow pipe for delivery to the ground surface.

In oil well drilling and producing operations the casing may be run through one or more oil producing strata, from which it may not be desired to take production until some later or indefinite future time. Accordingly, one of the most general practices has been to lower standard casing through intermediate oil bearing strata and to cement off the oil sands at the outside of the casing for future production. Then when it is desired to take production from an intermediate sand, the section of the casing opposite the sand has been perforated by cutting or punching tools, or by gun-type perforators, lowered in the well. Another method has been to initially fill the apertures of standard perforated pipe or liner with a solid substance, such as sulphur, which later is dislodged by creating an explosive force within the pipe. The apparent disadvantages of this method are the disruptive strains imposed on the pipe or screen, and the impossibility of assuring removal of the filling material from all the apertures.

Our primary object is to provide improved screen filling materials and method of using same, whereby it is possible to retain all the advantages of a preformed screen having a predetermined and most efficient aperture size and arrangement, and also a normally closed structure that may be opened at any time after placement in the well to clear the apertures for inflow of production oil, all in a manner assuring complete clearing of the apertures and without injury to the screening medium. In accordance with the broad aspects of the invention, we may use well screen of various known types in which the apertures may be formed in any suitable manner, size and arrangement. In order that the screen normally, i. e. when first placed in the well, will have a closed structure preventing fluid flow into or from the screen section of the casing, the screen apertures are closed by a material capable of later being removed by an acid reagent or solvent introduced to the well.

The invention provides for the use of a screen aperture filling material having various properties and prerequisites giving it outstanding suitability for this purpose. In meeting the requirements of such a material, one main purpose of the invention is to provide an aperture filling composition which is substantially insoluble in or unaffected by the normal well fluids, i. e. oil and water, but which is actively attackable by acid, say a solution of hydrochloric acid, to a degree permitting ready disintegration of the material and resultant opening of the apertures. Thus with its apertures initially filled by the material, the screen is capable of remaining in closed condition within the well despite immersion in the well fluids, and yet is capable of becoming fully opened by the acid treatment, say at such time as it is desired to take production through the screen.

The invention contemplates using an aperture filling material which is predominantly composed of one or a mixture of the substantially water insoluble metallic carbonates. The general class includes the carbonates of calcium, magnesium, barium, strontium, and zinc. Among these, certain carbonates are especially advantageous by reason of their susceptibility to the desired action and effect of the acid treatment, and for forming with additional components of the mixture, a hardened homogeneous mass effectively resistant to accidental dislodgement from the apertures. Calcium carbonate is used as a preferred component of the material by reason of its ready attackability by the acid solution and the resultant disintegration and removal of the material from the apertures. It is found that the material may be given superior properties with respect to its hardness and permanency or stability as a hardened mass, by the use of magnesium carbonate together with the calcium carbonate.

The magnesium carbonate used preferably is a calcined or partially dehydrated magnesite, which by reason of its pre-calcination, is capable of hydration or acquiring water of combination, and is further capable when mixed with the calcium carbonate and magnesium chloride solution, of causing the mixture to set and form a hard mass. The calcium carbonate and magnesium carbonate may be used in any suitable pro-

portions, ranging for example in the case of each, from 20 to 70%, by weight of the mixture. Particularly satisfactory results have been obtained using between about 40 to 45% each of the two carbonates. The latter desirably are finely ground, say in the order of 200 mesh or finer.

A suitable binder or adhesive is admixed with the carbonates. In the broad aspects of the invention, any suitable adhesive or binder may be used so long as it is adequately resistant to dissolution or attack by the well fluids. Accordingly, a suitable adhesive or binder may be selected from the non-water soluble glues, and particularly those less affected by hydrocarbons. The invention particularly contemplates, however, the selection and use of a binder not only for its adhesive qualities, but also because of its expansibility and capacity therefore for causing the mixture during the setting or hardening period, to expand within the screen apertures thereby forming a highly effective seal by reason both of the adhesive qualities of the binder and the expanded condition of the mass. To secure these advantages, casein preferably is used as the binder because of its low solubility characteristics, adhesiveness and property of expanding after mixing with water and being permitted to solidify. The casein content of the mixture may be from about 2 to 10%.

The mixture initially is formed as a plastic mass for placement in the apertures by mixing with the calcium and magnesium carbonates and casein, a water solution of magnesium chloride at a concentration of around 7 to 8 pounds of the salt per gallon of water. The effect of the magnesium chloride is to cause the magnesite to set and bind the carbonates in a hardened and cement-like mass.

In addition to providing in the mixture a high percentage of chemically disintegrable components, the presence of both calcium carbonate and magnesium carbonate is of great importance from the standpoint of giving the hardened mixture the essential density and high strength. Upon hardening in the presence of the magnesium chloride solution, the calcium carbonate and magnesium carbonate form their binary or double salts, the stereo chemical structure of which is quite different from that of either carbonate above. It appears that the double salt is formed by the activation of the crystalline surfaces of the two carbonates by the magnesium chloride, and it is possible that a surface solubilizing action takes place followed by a super-saturation resulting, upon cooling, in the formation of double salts having structural and chemical characteristics of single compounds.

For purposes of the present invention, the practical result and advantage is, as indicated, that the double salt has the desired acid solubility, while exceeding, by virtue of its crystalline structure, in the hardened mass, the strength obtainable by using either carbonate. The added effects of the organic binder in adhering to the metal pipe and in tending constantly to expand the material within the pipe apertures, thus complete all the properties required in the material to assure its intended purposes, i. e. normally to form a hard, strong and wear-resistant plug securely bonded against displacement out of the aperture, and one nevertheless capable of effective disintegration and removal by acid treatment.

The invention, including a typical method for placing the filling material in the screen apertures, may be further explained by reference to

the accompanying drawing showing a typical form of well screen, it being understood, as indicated above, however, that the invention is independent of any particular type or form of screen and is generally applicable to the conditioning of all such screens having apertures capable of being filled with a disintegratable material of the character described. In the drawing:

Fig. 1 is a sectional view of the normally open apertured well screen;

Fig. 2 is a fragmentary longitudinal section showing the filling material in the screen aperture;

Fig. 3 is a section on line 3—3 of Fig. 2;

Fig. 4 is a view illustrating a method of filling the apertures with the material; and

Fig. 5 illustrates a variational embodiment of the invention in a gravel pack liner assembly.

Referring first to Fig. 1, the screen may consist of a length of perforated well pipe or liner 10 having suitably formed apertures such as slots 11 cut in the pipe in circularly spaced, offset arrangement. Figs. 2 and 3 illustrate a usual shape for the apertures or slots.

In applying the aperture filling material, a plastic mixture thereof may be placed on a suitable floor or surface, as indicated at 12 in Fig. 4. After having inserted a temporary liner 13 within the screen to close the apertures 11 at the inside, the screen may be rolled over the material 12 to cause the material to enter and become tightly compacted within the apertures. Thereafter, excess material may be removed from the outside surface of the screen and the liner 13 withdrawn. The apertures 11 thus are filled with acid soluble plugs 14 which as the material is allowed to set, become hard and tightly bonded to the pipe by reason of the expansion and adhesive properties of the material.

Thereafter, the screen may be lowered and set at whatever location desired within the well, and the screen may remain so placed and in its closed condition until such time as it is desired to open the apertures. Acid, for example an aqueous solution of hydrochloric acid, then may be introduced to the inside of the liner by any suitable means permitting the acid to attack and disintegrate the plugs 14 to open the screen for the in-flow of fluid.

Fig. 5 illustrates a further embodiment of the invention as applied to gravel pack liners, particularly of the pre-packed type. In their general form and construction, such gravel pack liner assemblies comprise an inner perforated pipe or liner 15, and an outer screen or perforated pipe 16 annularly spaced from the inner pipe and suitably attached thereto as by connection 17 at the upper and lower ends of the outer screen 16 (only the lower end connection being shown). The annular space between the screens 15 and 16 is filled with a body of gravel 18 or other divided material forming in the assembly a foraminous bed and third screening medium.

In accordance with the invention, it is made possible initially to close the inner and outer screens 15 and 16 against the passage of fluid into or through the screen and gravel assembly, and to protect the screen apertures against clogging by foreign materials during lowering and setting of the assembly in the well. Apertures 19 and 20 of the screen sections 15 and 16 first are filled with the acid-soluble material in the manner previously described with reference to

the liner 10, and the gravel 18 is filled into the space between the screens. At any time after the assembly has been set in the well, hydrochloric acid solution may be introduced to the interior of the liner 15 to first dissolve or disintegrate the aperture plugs 19, and then to flow out through the gravel to attack and disintegrate the plugs 20 in the outer screen.

We claim:

1. A well screen comprising an apertured fluid passing medium, and a solid substantially oil and water insoluble material closing the apertures of said medium, said material comprising a metallic carbonate readily attackable by acid to disintegrate the material and open the screen apertures and a binding substance tending in the presence of water to expand said material within the apertures.

2. A well screen comprising an apertured fluid passing medium, and a solid substantially oil and water insoluble material closing the apertures of said medium, said material being composed predominately of finely divided particles of metallic carbonate held together by a substantially water insoluble adhesive tending in the presence of water to expand said material within the apertures, and said material being readily attackable by hydrochloric acid solution to disintegrate the material and open the screen apertures.

3. A well screen comprising an apertured fluid passing medium, and a solid substantially oil and water insoluble material closing the apertures of said medium, said material containing particles of calcium carbonate and magnesium carbonate uniformly distributed in the material and in sufficient quantity to render the material readily disintegrable by hydrochloric acid solution

and a binding substance tending in the presence of water to expand said material within the apertures.

4. A well screen comprising an apertured fluid passing medium, and a solid substantially oil and water insoluble material closing the apertures of said medium, said material comprising a hardened mass of metallic carbonate and casein as a binder, said material being readily attackable by acid to disintegrate the material to open the screen apertures.

5. A well screen comprising an apertured fluid passing medium, and a solid substantially oil and water insoluble material closing the apertures of said medium, said material comprising a hardened mixture of calcium carbonate, magnesium carbonate and casein, and the material being readily attackable by acid to disintegrate the material to open the screen apertures.

6. A well screen comprising an apertured fluid passing medium, and a solid substantially oil and water insoluble material closing the apertures of said medium, said material comprising, in parts by weight, 20 to 70% calcium carbonate, 20 to 70% magnesium carbonate, and 2 to 10% casein, and the material being readily disintegrable by acid.

7. A well screen comprising an apertured fluid passing medium, and a solid substantially oil and water insoluble material closing the apertures of said medium, said material being formed by admixing finely divided calcium carbonate, magnesium carbonate capable of acquiring water of hydration, casein and magnesium chloride solution.

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